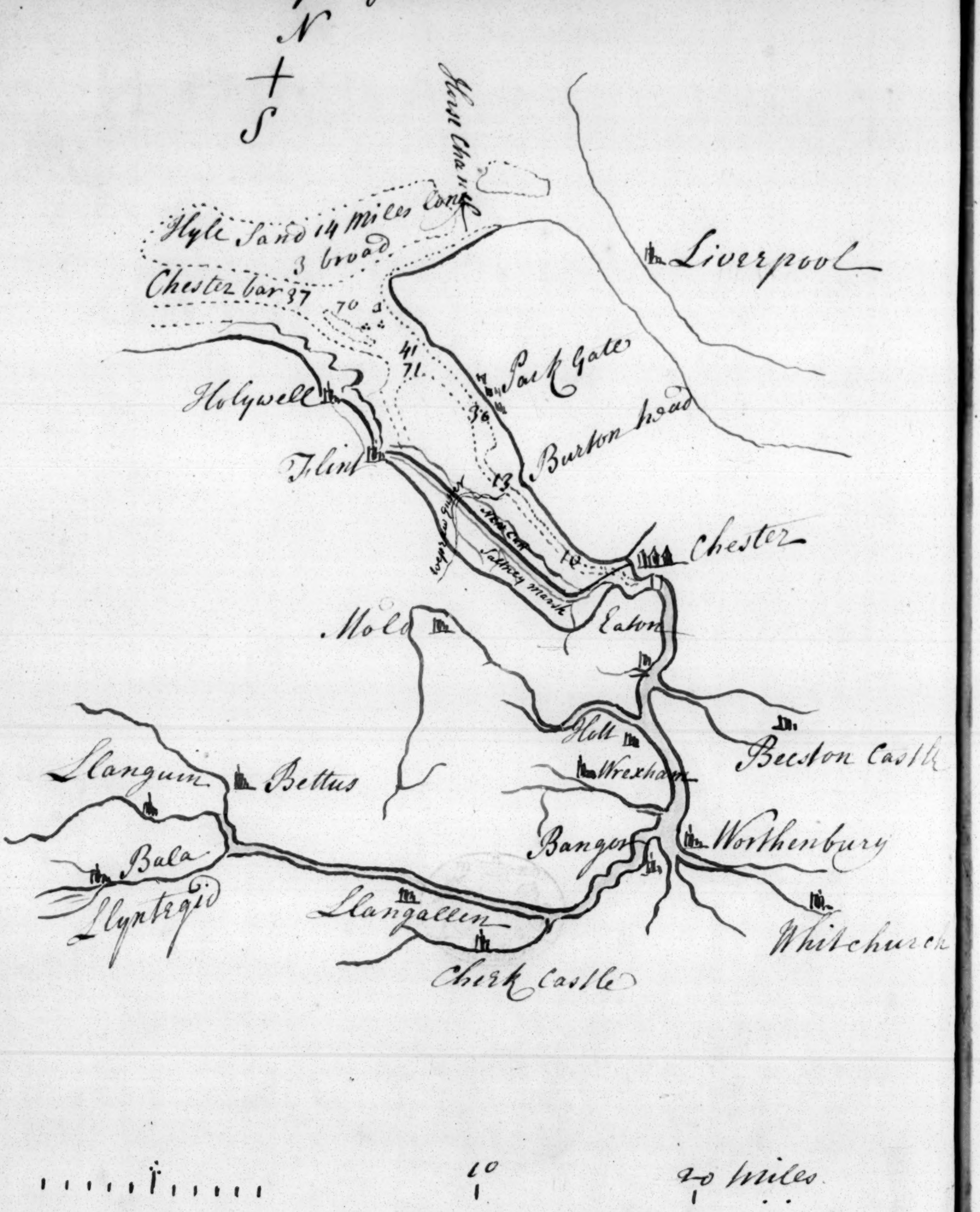
A Map of the River Dee



H: Badeslade (T.)

V3/p70 b

THE
New Cut CANAL,
Intended for Improving the
NAVIGATION
OF THE
City of *CHESTER*;

WITH

The *Low Lands* adjacent to the River *DEE*,

COMPARED

With the *WELLAND*, alias *Spalding* River, now Silted up,

AND

DEEPING-FENS adjacent, now Drowned.

ALSO

ARGUMENTS to prove that as the River *Welland* and *Deeping Fenns* were deſtroyed by Imbanking *Salt Marſhes* and making that River narrow, ſo the River *Dee* and the *Low-Lands* adjacent will be deſtroyed, if the *White-Sands* and *Salt-Marſhes* be Imbanked and the River made narrow, as is propoſed in Mr. *Grundy's* Book.

To which is added,

REASONS and EXPERIMENTS, ſhewing why a Flat and *Fenny Country* cannot be drained thro' a Sewer that has but Four Inches declivity in each Mile, with a refutation of Mr. *Grundy's* Demonſtration by which he endeavours to prove that it can. Done for the Uſe of Drainers.

WITH

A DEFENCE of thoſe GENTLEMEN who have been Undertakers to Drain *Deeping-Fenns*, againſt the Reflections of Mr. *Grundy* in which is ſhew'd the true Cauſe why the ſeveral Undertakings have not had laſting Succeſs: With a Hint of the Cauſe of the great Decay of late Years of *Navigation* and *Draining* in the Rivers of *Wisbech*, *Spalding*, *Bourn* and *Boſton*, which all fall into the ſame Bay.

ALSO

EXPERIMENTS, and REASONS agreeing with Sir *Iſaac Newton's* Theory of the Tides, relating to the Practice of taking a Level by the High-water-mark of a Spring-Tide, occaſion'd by Mr. *Grundy's* Aſſertion that, that method is founded upon falſe Principles, with Conſiderations on his method of taking the Level of the Country about *Spalding*, with an Inſtrument called a Spirit Level at upwards of 2,500 Stations.

> Spalding *of Old Time was the beſt of Three Outfalls, now the worſt; loſt by winning certain ſeveral Marſhes to the Seaward.* Rich. Atkins, *Eſq*; A.D. 1604.

CHESTER: Printed by *Roger Adams*. [Price Two Shillings.]

G.R III.

THE

PREFACE.

I MUST Confeſs my Self in ſome Meaſure puzzled, rightly to underſtand Mr. *Grundy*'s Book, He talks of Sir *Iſaac Newton*'s Principles and Theory of the Tides, yet ſhews no Regard to them. He declares the New Cut at *Cheſter* will be the ruin of Navigation, yet afterwards Argues for a narrow River, and taking in Land from the Sea, which will have the ſame bad Effect as the New Cut. He ſays, he does freely confeſs my Remarks on the Subject of Navigation and Draining, are the beſt Extant and yet preſently after Writes directly in Oppoſition to them. And in order to Introduce a groundleſs Opinion, without Grounds, believes I am Miſinform'd about Deeping Fens and the River *Welland*; And apprehends, that the Inſtances I bring as parallel to *Cheſter*, are not ſo in Fact.

BUT ſince He has given no reaſons for his belief and apprehenſion, I think, I have no great occaſion to Juſtifie my Self, to the Judicious and Rational on that ſcore. Yet as He has form'd an *Hypotheſis* upon a ſuppoſition of my being miſinform'd in ſome Circumſtances, and miſtaken in ſome Parallel Caſes of Ports, mentioned in my Pamphlet (of the reaſons, why the Works now executing at *Cheſter*, will deſtroy the Navigation of the River *Dee*,) *&c.* It may not be amiſs to ſhew, that I was not miſinformed, nor miſtaken in either, that ſo, thoſe that are Concerned on either ſide the Queſtion, may be confirmed in a right Opinion, and Act conſiſtent with their true Intereſt. For I can't help obſerving of Mr. *Grundy*, that as by the reflections he has caſt on Captain *Perry*, and on all the Undertakers of Draining deeping Fenns, *viz.* That they miſcarried for want of taking the Levels of the Country true, (which I here prove, is notoriouſly falſe,) he would

perſuade

perſuade the Inhabitants into a Scheme of his, founded upon his taking the Levels truer (which he cannot do) and upon a ſuppoſition, that a Flat Fenny Country, may Drain thro' a Canal, that has but four Inches declivity in each Mile, which I here prove it cannot do. Even ſo He ſuppoſes, I muſt be miſinformed and miſtaken, in order for him to introduce a Scheme, to make People Intereſted believe that the taking inn *Salt-Marſhes* and *White Sands* from the *Sea*, and the making the River *Dee* narrow, will amend and preſerve the Navigation; when at the ſame time the River *Welland* is, and long has been Choaked up, and Deeping Fenns (where he has been employ'd to give a Scheme) are Drowned by ſuch Practices on that River.

THOMAS BADESLADE.

March 25. 1736.

The *New Cut* CANAL,

INTENDED

For improving the NAVIGATION of the City of *CHESTER*, with the *Low Lands* adjacent to the River *DEE*, compared with the *WELLAND*, alias *Spalding* River, now Silted up, and *Deeping Fenns* adjacent, now Drowned, *&c*.

I Hope the following Particulars will make it appear that I was not miſinform'd in any Circumſtances relating to *Deeping Fenns*, and the River *Welland*; and alſo that the *New Cut*, and the Low Lands about *Cheſter*, are parallel Caſes with the River *Welland*, and the Low Lands about *Spalding*, call'd *Deeping Fenns*.

When Capt. *Perry* was executing his Scheme for draining thoſe Fenns, and amending that River, I was at *Exton Park* (near *Stamford* on the *Welland*) about 20 Miles off *Spalding*: I heard the *Captain* was out of Order, and went to ſee him, to invite him to an upland Country and healthy Air.

A Tenant to a Relation of mine, and ſome other Natives and underſtanding People ſhew'd me all the Works (before I went to the *Captain*) particularly St. *James's Drain*, which had been cut by former Undertakers from *Deeping Fens*, beginning above *Spalding*, to convey the Fenn Waters into the *Welland*, three Miles below *Spalding*; but being uſeleſs, Capt. *Perry* cleans'd and open'd it, propoſing to turn the Waters of the River *Welland* into *Deeping Fens*, near *Deeping*, and lay it under Water to the height of the Banks of that Drain (which had a *Sluice* againſt the *Sea Tides* at the end of it) and thought by the force of that Water to ſcour the *Welland* from that Drain to *Sea*; but this did not take Effect.

A like Project was tried not many Years before on the *North Level* by floating it with the Waters of the River *Nene*, and turning them through *Shire Drain* to deepen *Wisbech Outfall* without Effect.

Above *Spalding* at the South End of the Town toward *Deeping*, Capt. *Perry* was making *Sluices* and *Hatches* croſs the River *Welland* to hold up Water to make a *Scour*, by the force of which he expected to drive the Sand to *Sea* and deepen that River. Between *Spalding* and *Deeping* he had many Hands at Work, raiſing and mending the weſt *Bank*, of *Welland*, to ſecure *Deeping Fenns* from Land Floods.

At the *Captain's* Houſe I ſaw a *Map* of *Welland River* and of *Deeping Fenns* lately made by one Mr. *Cuſhee* a Surveyor of my Acquaintance, I wrote to him and he ſent me a Copy of it, and of the *Levels* he took.

Capt. *Perry* underſtanding that I employ'd a great many Hands in making *Banks* for ſome Water-Works I was executing, deſir'd me to ſpare him ſome, becauſe he ſaid he intended to make a Puſh. I ſent him a whole Gang, and gave Inſtructions and Pay to one of them whoſe Capacity was ſufficient, and one who I could truſt, and he gave me all the Information he could as they went on: He ſent me word when the *Scour* was to be tried, and I went to ſee it.

Capt. *Perry* had all the *Hatches* drawn up at once by means of Men walking in a large *Wheel* at each end of a long Axis or Shaft, to which the Chains were fix'd that drew up the *Hatches*, like the Wheel of a Crane.

The Torrent ruſh'd down with great Rapidity and Noiſe, furiouſly tore up the *Sand*, and made the Water replete with *Silt*. The Capt. was very alert and highly ſatisfied with the Effect the *Scour* had at its firſt beginning.

I follow'd the *Scour* down the River, and ſaw ſeveral of his Men at different diſtances ſtirring the *Sands* with *Rakes*, *Shovels*, &c. and *Porcupines* were made uſe of; but the *Scour* loſt moſt of it's Force in a very little ways running, and after it ran about three Miles againſt St. *James's* Drain Sluice, it's Water was ſo ſlow, ſhallow and weak, that it would not buoy up the *Sand*, far that was mix'd with it by the Men's ſtirring it, ſo that hardly any *Silt* was driven out to Sea, and the *River* was not deepen'd to Seaward by the *Scour*.

When I return'd, I went to the *Hatches* as ſoon as they were ſhut down, and obſerv'd that the Fall of Water had gull'd a Hole beyond the Sluice, and raiſ'd a Barr of Sand in much the ſame manner as is commonly ſeen in Pools at the tail of a Mill.

This was about the Year 1730. *The Facts Mr.* Grundy *found upon the River* Welland *was* five Years after, viz. in 1735. 'Tis very probable ſince my View of it, a Floor has been laid at the *Hatches* to prevent the *Scour's* continuing to Pool a depth that might hazard the blowing them up; (ſuch a Floor was made at *Shire Drain* Sluice, in *Wiſbech* River, for that End) But for him to ſay there was no Hole, except where it was dug out with Spades by Capt. *Perry's* Order, is very extraordinary. Who can ſuppoſe he would dig Holes in the *River*, or that a Hole ſhould remain five Years afterwards? Doubtleſs ſuch Hole was made by the fall of the Water thro' the *Hatches*. Thus much to ſhew that I was not miſinformed in any Circumſtances relating to this Affair. Next

In order to ſhew the Parallel between *Spalding* River alias *Welland*, and *Cheſter* New Cut, I ſhall compare Mr. *Grundy's* Obſervations made there, with mine made here.

He ſays, from Capt. Perry's *Sluice* (at the South End of *Spalding*) *to the End of the narrow part of the River* Welland *below* Waſh-way-houſe, *is upwards of* 9 *Miles and a half*.

I ſay from *Cheſter* Cauſeway or *Cheſter* Bridge, to the end of the narrow New Cutt at *Weppraw Gutter*, is about the ſame diſtance

He ſays the floor (the Captain call'd it Apron) *of that Sluice at* Spalding, *was higher by* 22 *Inches than the bottom of its Channel at its Mouth* 9 *Miles and a half to Seaward*; *which is a ſmall* deſcent.

I ſay, that the bottom of the River at *Cheſter* Cauſeway, is at leaſt four Foot lower than the bottom of the New-Cut at *Weppraw Gutter*, about the ſame diſtance, which is a great *Riſe* in the Cut all the way from *Cheſter*.

He ſays, he found a Barr *of* Sand *no nearer than upwards of Three Miles below the Sluice*:

I ſay, the New Cut is a *Barr* of Earth riſing from the beginning, and almoſt all the Length of it, ſo much, that from *Stowbridge Gutter* to *Wepraw Gutter*, the Cut is at leaſt *ſix Foot* higher than the bottom of the River where the Cut begins, and the end of the Cut is *ſixteen Foot* higher than the bottom of the Old Chanel of the River *Dee*, at *Burton-Head*, over againſt *Weppraw Gutter*.

He ſays, the Sluice ſeems to have been in ſome degree Uſeful, for that the Navigation was worſe before the Sluice was ſet down.

But if the *Sluice* had been Uſeful toward *ſcouring* the *River*, how came there to be a *Barr* of *Sand* three Miles below the *Sluice*? How comes it to paſs that the bottom of the *River* has no greater Deſcent than 22 Inches from the *Sluice* to its mouth 9 Miles and a half off the *Sluice*, after the *Scour* has been us'd five Years, and wet Years too? How comes it to paſs that *Mr.* Grundy *was employ'd by the Adventurers of Deeping Fens, to Survey, and take Levels, and to give a Scheme for bettering the Navigation and Draining*, if the *Sluice* and this *Scour* had been of Advantage to the *River*? This ſurely can't be True, for the *London Subſcribers loſt* 6000 Pounds in the Attempt, and Mr. *Grundy* acknowledges, that in the Years 1731, 2, 3, 4, 5. the *River Welland* was very bad and almoſt loſt to *Navigation and Draining*.

By the Caſe of this River, the fate of Cheſter *Navigation is pointed out, and made plain to a Demonſtration.*

The *River Welland* is Narrow, has a ſmall Deſcent, and its bottom is *Sea Sand*, caus'd to be Choak'd up therewith, by *Inning Salt-Marſhes*, and making *Banks* croſs the *Creeks*, thereby depriving the *River* of its ancient quantity of Water, and by which it was formerly kept ſo Deep and Open, that it was the beſt Outfal it thoſe Parts, but cannot now, as is above ſhewn, even by *Scours* be made Deep. So that it's bottom is higher than the *Fens*.

The *New Cut at* Cheſter is Narrow, has a conſiderable Aſcent, and its bottom is *Earth* moſtly a *ſtrong Soil*, therefore the bottom never can be Deeper than Digged; and when the River *Dee* to *Seaward* is depriv'd of its ancient quantity of Tide Water, by taking *Inn White-ſands*, *&c.* 'twill grow up to *Seaward*; and the New Cut will grow up with it, even tho' it be Cut at firſt as Deep as the *Act* requires, or as deep as *Welland* once naturally was. So that no *Veſſels* could come to *Cheſter*, more than they do to *Spalding*; and all the Low-Lands here will be lower than the bottom of the Cut, and will be in the ſame Drowned Condition as are *Deeping Fens* there.

From what has been ſaid, I hope it doth appear, that I am neither miſtaken in the Circumſtances, nor in the Parallel; tho' Mr. *Grundy* certainly miſtakes Me, occaſioned I ſuppoſe, by his making no diſtinction, in my Book, between the old *River Dee*, and the *New Cut*, relating to the fall from *Cheſter* to the *Sea*.

I ſaid, *P. 6.* That High Water at *Cheſter* in an *ordinary Spring Tide* is 60 Foot higher than the bottom of the *River* in *Hyle-Lake*, to ſhew how *Hyle-Lake* by the Operation of the *Tides* is kept Deep; but I did not ſay, that Low Water-Mark at *Cheſter* is Sixty Foot higher than Low-Water-Mark in *Hyle-Lake*; ſo that He is Miſtaken in the inclination of the Plane in that particular, and alſo in this, that *Hyle-Lake* is 20 Miles off *Cheſter*, even as far off as *Boſton deep* is off *Spalding*; whereas from Capt. *Perry*'s *Sluice*, 'tis but 9 Miles and a half to the Waſh-Way Houſe, to which Place from the *Sluice* there is a Deſcent of near two Foot. But after all, this is not the proper Parallel, the Parallel Caſe to be Argued is between *Cheſter New Cut*, and *Welland River*.

Here is no Fall no Deſcent in the *New Cut*, but a Riſe of 16 Foot; in the *River Welland* there is a Fall of near two Foot in a length equal to the length of this *New Cut*; the difference of the Caſe then between *Che-*

ſter and *Spalding*, is, that the *New Cut* would be more difficult to be made Deeper eight to one than the *Welland*, tho' we had a *Sluice*, and only *Sand* to *Scour* out. And therefore to *Scour* the *New Cut* deep enough is utterly Impracticable, as appears from Captain *Perry*'s experiment in *Welland River*, *&c.*

It is no wonder Mr. *Grundy* does not apprehend Me, where I ſay, *P.6.* That after *Saltney-Marſh* is *Imbank*'d, and the *White-ſands* are gain'd from the *Sea*, not only the *Navigation* will be Loſt, but alſo the Low Lands adjacent to the River *Dee*. And again, in *P.* 8. Therefore when the *White Sands and Salt Marſhes* belonging to *Cheſter River* are *Imbank'd*, of neceſſity *Hyle-Lake* and the *Barr* muſt grow up, and the *Navigation* be Deſtroy'd, for want of a ſufficient *Flow* and *Reflow* of the *Tide-Water* to keep them open, in like manner as did the Outfal at *Rye*, I ſay, it is no wonder he does not apprehend Me in this, ſince he miſconſtrued the Parallel between *Cheſter* New Cut and *Welland* River. But when he ſays, *That there are Iſtances of a poſſibility that what we apprehend to be Parallels may not be ſo in Fact.* He would have done well to have mention'd ſome Inſtances that he knew to be ſuch, and not have printed an Opinion founded only upon a belief that I was * miſinform'd in ſome Circumſtances relating to *Deeping Fens* and the *River Welland,* and *that there is a poſſibility that the Inſtances I bring as Parallel to* Cheſter, *may not in reality be altogether ſuch.*

Since Mr. *Grundy* ſays, he can't give his Opinion with certainty, *without Surveying and Levelling the whole*, every body muſt believe this Opinion he gives in his Book, *is not his own*, and are left to gueſs whoſe it muſt be. He ſays, he goes himſelf, by Sir *Iſaac Newton*'s Principles, but what is here publiſh'd is againſt his *Principles*, and againſt his *Theory* of the *Tides*. Sir *Iſaac* ſays, " *The main buſineſs of natural Philoſophy is to Argue from* " Phœnomena, *without feigning* Hypotheſis, *and to deduce cauſes from effects*,

---

* He has treated Captain *Perry* in the ſame manner in a Sheet printed, A. D. 1734, to endeavour to prove, that all the Attempts that have been made for Draining *South-Holland* in *Lincolnſhire*, have not ſucceeded, on Account of a wrong Method being us'd in taking the Level of the Country. And to prove, that the Levels have not as yet been taken with any Acuracy or Judgment. He ſays. *P.* 4. " *The famous Captain* Perry *took all his Levels by* " *no other Method than ſounding the Drains with a long Staff, by taking the depth of the Water* " *from the Surface to the bottom in ſeveral Places along the ſame; then by taking the diffe-* " *rence of thoſe Depths, he immagin'd he had got the juſt Fall of the ſame from an Horizontal* " *Plane: But no Level can be taken by this Method, and muſt be entirely Falſe.* In order to prove this method Falſe, he falſely ſuppoſes the Water to be actually in Motion, and running thro' the Drain to its Outfal, in which caſe it has a Deſcent. But the Water was at reſt in the Drain, Captain *Perry* took the Level of by that Method, *viz.* St. *James*'s Drain, the Sluice Doors being Silted up, and kept ſhut by Sea Sand. So that the Level was truly taken, and it was the beſt Method to take it, the Surface of the Water being an Horizontal Plane. And this diſingenuous Reflection is caſt on Captain *Perry* (ſince his Death) in order to make the Country believe, that the Levels being taken upon falſe Principles, the reſt of the Proceedings muſt be Falſe too, with regard to Draining, and therefore they did not ſucceed, nor can ſucceed till Mr. *Grundy* takes the Levels more true, which he cannot do. Nor can I any more believe, that all the Undertakers did not cauſe the Levels to be taken as true as Mr. *Grundy* can take them, than I can believe, that there never were any Mathematicians capable of doing it, before Mr. *Grundy*. *N. B.* The famous Mathematician Sir *Jonas Moore* was employ'd by the Undertakers for draining *Bedford-Level* of the Fenns, to make the Surveys take the Levels, *&c.* But he did not give the Scheme for Draining; That was given by Sir *Cornelius Vermuyden*, an Engineer expert in the Art of Banking and Draining. He had been employ'd by the Commiſſioners of Sewers on the Banks of the River *Thames*, and had by the Appointment of King *James* I. drained *Hatfield-Chaſe*, 90,000 Acres of which was hurtfully ſurrounded.

Likewiſe *Thomas Lovel*, Eſq; who undertook to Drain deeping Fens, I. King *James* Firſt, was a Man skilful in ſuch Works, wherein he had been beyond the Seas, much us'd and employ'd, and was deſired by the Inhabitants, as one fit to undertake the Draining the ſaid Fenns. And yet Mr. *Grundy* ſuppoſes, theſe experienced Men did not know how to take a Level.

I doubt, there are thoſe, who will think from Mr. *Grundy*'s Reflections and Reaſoning, that he knows nothing in this Affair, but how to take a Level.

Opticks."

Opticks." *Q.* 28. But here an *Hypotheſis* is feigned, *viz.* " *That all the*
" *Lands and Sands above* Weppraw-Gutter, *may be made good Lands without*
" *prejudice to the Navigation or to the Draining the adjacent Lands, and that the*
" *Imbanking Salt-Marſhes in ſome Degree is ſo far from being prejudicial, that*
" *it is of the higheſt Advantage to both. That a large and deep Chanel, whoſe*
" *Capacity is found by Calculation, to be juſtly Proportion'd to fit and receive all*
" *ſuch Water as muſt flow and Reflow thro it, has a greater Momentum to remove*
" *any Obſtructions, than the largely diſproportioned and widely extended ſhallow*
" *Chanel; and if ſuch a Chanel could be by Art made, then conſequently the re-*
" *maining Sands as far as* Burton-Head, *above the Capacity of ſuch a Chanel*
" *might be Banked in, and made good Land without any Prejudice to the Navi-*
" *gation.*"

But this is feigning an *Hypotheſis* and not arguing from *Phænomena*, and therefore does not carry any conviction with it, to command our Aſſent; nor can be regarded till he ſhews according to Sir *Iſaac Newton*'s Rule, where ſuch a *Cauſe*, or ſuch a Work, has had the real Effect, which he here feigns.

I have taken that method to make my enquiries after Truth. For Inſtance, being employ'd at *Lynn*, in relation to their *Navigation*, and in *Bedford-Level* in relation to their *Draining*, I found at *Lynn* and in the *Fenns*, that the *Harbour and River* were choaked with *Sea Sand*, in conſequence whereof the *Navigation* was Prejudic'd, and the *Country* was Drowned, whereas the *River* had been Deep and the *Country* had been Dry; my buſineſs was to find out the *Cauſe* of this Effect. After much *Surveying*, *Levelling*, and *Study*, and after many Obſervations on the *Tides*, I found it was cauſed by a *Dam and Sluice* made croſs the *Old River*, and by a *Strait Cut* of a high Situation, into which the *Freſh-Water* and *Tide* had been turn'd, as deſcrib'd in my *Hiſtory* of the *Navigation* of *Lynn*, and of *Draining* in the great Level of the *Fenns* call'd *Bedford-Level*.

And from thence I argue, if a like Work be Executed at *Cheſter*, it will have a like Effect.

And when Mr. *Grundy* takes this Method. He will find that *Welland* was once a deep *River*, the beſt of Three in thoſe Parts, now the worſt. He will find the Cauſe of its Decay, to have been taking in *Salt Marſhes*, *Damming* croſs the *Creeks*, and depriving the *River* of its ancient quantity of Back-Waters; he will find that the more *Salt-Marſhes* were taken in, the more the *River* decay'd, inſomuch, that *Deeping Fenns*, once a fine Country, hath been for a long time rendred unprofitable, the *River* being *ſilted* up too high to carry the *Fenn Waters* to *Sea*, and ſo high, that the *Navigation* of *Spalding* is almoſt loſt, nor could Captain *Perry* recover the *River*, or *Drain* the *Fens*.

When Mr. *Grundy* finds, that after the taking in *Salt-Marſhes*, and making the *River Welland* Narrow, inſtead of the Waters having a greater *Momentum* to remove Obſtructions, they had not force enough to keep the *Chanel* deep, that was deep before the *River* was made Narrow, and the *River* ſilted up, to the great Prejudice of *Navigation* and *Draining* at *Spalding*; I doubt not, but he will explode the *Hypotheſis* printed in his *Book*, and own, if executed here, that ſuch *Works* muſt prove alike deſtructive of the *Navigation* at *Cheſter*, and cauſe all the Low Lands to be in the ſame drowned Condition, as are *Deeping Fenns*; ſince like *Cauſes* muſt neceſſarily produce like *Effects*.

As to the two Propoſitions of Mr. *Grundy's*, the Firſt *to prove*
" *that Water will move along a River or Canal that has but four Inches*
" *Fall in each Mile, and the ſecond to prove no Level can be taken betwixt two*
" *diſtant places in any* Chanel *by the different height* * *of the ſame Tide at thoſe*

---

* High Water Mark.

“ *two places.*” As they do not at all affect any thing I have advanc'd, and as he doth not ſay they do, and as it would not at all alter the Caſe of *Cheſter*, if what he aſſerts be granted, I have no occaſion to regard them, nor did intend it; but being deſir'd to examine them, becauſe he applies the four Inches fall in a Mile to draining *a flat or fenny Country*, And aſſerts that taking the *Level* by the *Tides* is grounded upon falſe *Principles*, and that the taking it by *Inſtruments* is the moſt exact way. I ſhall, as deſir'd, and for the Satisfaction of *Drainers*, make Critical Remarks on them. And in the firſt place:

His firſt Propoſition is not ſtated right, he makes in Fig. 1. the Surface of the Water ABCD in his Reſervoir, to be 4 Inches higher than the Horizontall Surface QN of the Water in the Canal (viz. the height QB) and then asks “ *if the Sluice* BDFG *of the Reſervoir, and that at* NW, *at the end of the Canal be open'd, will the ſaid Water have any Motion at all along the Canal?* In this Propoſition and Figure, he gives the Water a fall of Eight Inches in a Mile, that is to ſay, 4 Inches fall in the Reſervoir above the Surface of the Water in the Canal, viz. QB, and 4 Inches at the end of the Canal from the ſurface to the bottom, viz. NS; for ſince both Sluices are open the Water NS, at the end of the Canal will be run a Mile by the time the Water QB, in the Reſervoir is run to S the bottom and end of the Canal, ſuppoſing the Canal a Mile long.

His Demonſtration as he calls it, is as much againſt the purpoſe he intends it for, as his Propoſition! He ſays, “ *if the* * *Sluice at* NW *and* BDFG *be both drawn up, it is plain by Conſtruction, by the Laws of Gravity and from Mechanick Principles, that the Particle* i. *will deſcend to* k. *and there its Preſſure to move forward will be in proportion greater than when at* i. *as* bk *is greater than* ai, *and that the Particle* k *being in Motion, will be continually accelerating, and will be ſo much greater at* l, *as a Body falling from* c *to* l, *would be accelerated more than it would be in falling from* b *to* k; *by the ſame Laws it muſt move to* m, n, p, q, S.” But in this he ſuppoſes an Impoſſibility, viz. that while the Water is moving in the bottom of the Drain from i to k, to l, m, n, p, q, S, with an Inclination of 4 Inches in a Mile, the Water of the Reſervoir moves in an horizontall Plane from a to b to c, d, e, f, g, h; elſe how is the motion of the Water at the bottom accelerated in proportion to the length of the Lines bk, cl, dm, en, fp, gq, h S, each Line ſhewing a greater depth, and conſequently a greater weight of Water. This miſtake ſhews how eaſily Men may be miſtaken in Speculations of the Theory, deceiving themſelves, and contributing to deceive others with imaginary Demonſtrations, for want of knowing better from *Practice*.

This Demonſtration as he calls it, being falſe, the Inference drawn from it *That Water* (in the ſame Inclination) *will be continually accelerating*, is equally falſe too; and Dr. *Lowthorp* F.R.S. ſhews by an Experiment that the Velocity of Water diminiſhes in proportion to the length that it runs: Therefore I cannot give my Aſſent to what he calls a Demonſtration, and muſt give my Diſſent to his Concluſion.

He ſays, “ *if we ſuppoſe the River or Drain* V, *to ſupply the Reſervoir with Water from ſome greater Inclination than that of the ſaid Canal, which is generally the Caſe where Waters are convey'd by Drains thro' a flat and fenny Country to their Outfall, the Water in the Canal* MNRW, *will have its Velocity* (*in proportion to the inclination of the River* V) *increas'd, tho' the ſaid Canal hath no greater Inclination than 4 Inches in a Mile.*

The Velocity of Water cannot be increas'd, while its Declivity continues the ſame; when its Velocity is increas'd, its Declivity will be greater in proportion. But the Inclination of the Canal is here fix'd at 4 Inches in a Mile, therefore if the Velocity of the Water in the Canal be *endeavour'd* to be accelerated by ſupplying it from the River V, of a greater Inclination, the Canal will be ſurcharg'd at the beginning of it, and run over. This Truth is demonſtrated by *Engineers* by *Hydroſtatick* Principles, and 'tis ſo well known by Experience to *Fen-Men*, that they have a *Sluice* at the Land End of their Drains (as for Example, at the *North Level* end of *Shier Drain*, beſide the *Sluice* at the Sea end into *Wisbech* Outfall) to hinder a greater quantity of Water from running to the Drain, than its Declivity will carry off, otherwiſe 'twould run over. And there is a Sluice-keeper on purpoſe to watch it.

---

* He means Hatches, for there is no drawing a Sluice up.

This Propoſition of Mr. *Grundy's* not in the leaſt proving, that Water will run (and that a flat and fenny Country may drain) thro' a Canal that hath no greater Inclination than 4 Inches in each Mile, the *Publick* has nothing but his Word for it; he ſays, "*it is a receiv'd Truth amongſt moſt modern Engineers.*

But *Mathematical* Knowledge and Experience is againſt what he ſays; for inſtance, we know by *Hydroſtaticks*, that the Velocity of Water in *Drains* is greater or leſs, as its Declivity or Fall is more or leſs; we know by *Mechanicks* that there is a *Friction* which retards its Motion, which alſo is further impeded by its ſoiling thro' Weeds, and is quite ſtopt from running out of the Drain for 6 or 8 Hours in 25, by the *Tides* putting up and ſhutting the *Sluice Doors* at the end of the *Drain to Seaward.*

When Water has but a ſmall deſcent, the *Friction* of its Particles againſt the bottom and ſides of the *Drain* obſtructs its Motion very much; if its Motion be obſtructed the Declivity of its Surface is made leſs. In a *Drain* that has ſo little as 4 Inches Declivity in each Mile, the *Friction* will be ſo great as to retard the Motion of the Water one half in point of time, conſequently the inclination of the Surface of the Water in the *Drain* will be but 2 Inches in each Mile: The *Sluice* Doors will prevent it running to *Sea*, at leaſt 6 Hours in 25; this will again ſo retard the Motion of the Water as to make its Inclination, but little above 1 Inch in a Mile; and the Weeds it ſoils thro' (for a Drain cannot be kept quite clean from Weeds) will occaſion the Water's having ſo little Declivity, that the Water of a drowned *Fenn* can never be carried to *Sea* thro' a *Drain* whoſe Inclination is but 4 Inches in each Mile: And from Experiments that I have made in *Drains* by ſhutting *Sluices* at the ſame Inſtant of time at known diſtances. (When the Water has had but the leaſt perceptible Motion,) and confining the Water between the *Sluices* till it was at reſt and came to an Equilibrium or horizontall Level, it never ſettled leſs than 3 Inches at the upper *Sluice*, nor riſe leſs than 3 Inches at the lower *Sluice*; the *Sluices* being at a Mile diſtance, as *Hill's Sluice* and *Gunthorp Sluice* upon *Shier Drain*; which ſhews that Water cannot uſefully move to drain Land, unleſs it has at leaſt a Declivity of 6 Inches in a Mile: And this Deſcent is not ſufficient to drain any Scope of *Fenny* Land, becauſe of the Waters *Friction* and ſoiling thro' Weeds, the Wind alſo often retarding its Motion, and *Sluice* Doors ſtopping it for 6 or 8 Hours in 25.

When the *North Level* was well *drain'd*, the *Shier Drain* which convey'd its downfall Waters to *Sea* had an Inclination of 12 Inches in every Mile, to *Wisbech Outfall*.

When the Province of *Marſhland* was well drain'd, the Declivity of its *Drain* was greater than 12 Inches in every Mile thro' *Knight Gool* into the River *Ouſe*, or *Lyn River*.

When the *Great Level of the Fens call'd Bedford Level* was tolerably drain'd there was 10 Foot fall at the lower end of the *Fenns* from their Surface at *Salters Lode*, to Low-Water Mark in the *River Ouſe*, beſides 6 Inches in each Mile deſcent in the ſurface of the Fens towards the River. But when the

Wisbech River and the *River Ouſe* (were for Cauſes given in the Hiſtory of thoſe Rivers and of the Fenns) choaked up, ſo that the Declivity of thoſe Drains with reſpect to their Outfall, came to be but *6*, 5, or 4 Inches in each Mile, the *North Level*, *Marſhland*, and the *Fens call'd Bedford Level* could not drain.

Theſe Inſtances ſhew, that the many Attempts to recover *Deeping Fenns*, and to drain them, have not miſcarried for want of a right Method to take *Levels*, as Mr. *Grundy* inſinuates; but becauſe the River *Welland* and the *Outfall* to *Sea* has by degrees been choak'd up with Sea Sand, too high to receive the *Fenn* Water thro' the *Drains* that were made to convey it to *Sea*, which *Drains* were of uſe at firſt making, inſomuch that *Thomas Lovell*, Eſq; did *Drain Deeping Fenns* for the Time being at the Charge of about *Twelve Thouſand Pounds*; and he had his ſtipulated Reward of one third part of the *Fens* alotted to him, being about *Ten thouſand Acres*, by a Law made at *Spalding* 43 *Eliz.* and it was by Surveyors divided and ſet out, ſays Sir *William Dugdale*, Page *206*. But it had no laſting Succeſs, the Sea Sand ſo increaſing as to choak up the *Outfall* cauſed by the taking in Salt Marſhes. The Earl of *Exeter's* Drain was well deſigned and well placed and exiccated thoſe *Fens* for a Time, which ſhews, tho' their works had no Duration, that they took the *Levells* true. Theſe expenſive Experiments demonſtrates, that unleſs the *Outfall* of a *River* to *Sea-ward* can be kept from choaking up, it is in vain to hope for any laſting Succeſs in Works made for Draining: And the *Sands* having continued to increaſe more in the *Æſtuary* or *Bay* (into which the River *Welland* falls) from the time the *Great Ouſe* or *Lyn River* and its *Outfall* has been choaked up, than they did before; therefore until that *Outfall* be recover'd to *ſcour* out the *Sand*, and make a deſcent to *Sea* for the ſmaller *Rivers* that empty their Waters into the ſame *Bay*, the *Outfall* of *Wisbech*, *Spalding*, *Bourn* and *Boſton Rivers*, will *ſilt* up more and more, by which means no Undertakings for *Navigation* or *Draining* in thoſe Parts how ever well calculated for the time preſent, can have laſting Succeſs.

Mr. *Grundy's* ſecond Propoſition, *to prove that the difference betwixt the riſing of the ſame Tide at any two different parts, as* H *and* F *in any open Bay or Chanel cannot give the juſt Inclination of the Plane betwixt thoſe two Places.*

His Speculative Demonſtration of this Propoſition doth not prove it: Th Waters of Inland Rivers cannot run to Sea indeed, without having a Declivity in proportion to their Velocity. But the Waters of the Sea, their Tides * being propagated by Attraction are drawn up Hill, their higheſt Part be-

---

* The Tides could no way be accounted for 'till Sir *Iſaac Newton* found out the Principle and Properties of univerſal Gravitation; that is, the Force whereby, not only every Particle o Matter in each Planet tends to the Center of that Planet; but alſo that whereby the Planets reciprocally tend to one another, and the whole Chorus of them generally to the Sun, as being by far the greateſt Body, as alſo that the Force of the Attraction exerted by thoſe Bodies, at different diſtances, is as the Squares of thoſe diſtances; from which Principles the general Cauſe of the Tides may be ſufficiently explained.

The Moon revolves as it were round the Earth in 27 Days, 7 Hours and 43 Minutes at the diſtance of 240,000 Miles from its Center, having but about a fortieth part of the matter contained in the Earth. The Earth at the diſtance of about 81 Millions of Miles revolves round the Sun in 365 Days 5 Hours and about 49 Minutes. His quantity of Matter is about 227,500 times greater than that of the Earth.

The Earth then attracts the Moon in a ſuperior Degree, and confines it from flying off in a Tangent-Line to its Orbit. The Moon in its turn reatracts the Earth in a certain Degree, the ſolid Parts whereof being Rigid, ſeem not affected by it; but the Fluids yielding thereto, riſe, ſwell, and thereby ſeem to own its Power. The Sun in like manner attracts the Earth, ſo as to preſerve it in its annual Orbit; and alſo in ſome ſorts affects her Fluids; but by reaſon of his very great diſtance, in a degree ſeemingly leſs than the Attraction of the Moon.

It being demonſtrable that the Earth is within the Sphere of the Attraction of both Sun and Moon, it follows, that the equality of the Preſſure of the Gravity of matter, or its generally tending toward the Center of the Earth is thereby occaſionally diſturbed. Was the Earth entirely free from ſuch Actions of the Sun and Moon, the Ocean being equally attracted on all ſides by the force of Gravity would continue in a perfect Stagnation without either Ebbing or Flowing: But ſince the Caſe is otherwiſe it needs muſt riſe higher in thoſe places, wherever the Actions of the Sun and Moon diminiſh its Gravity.

ing

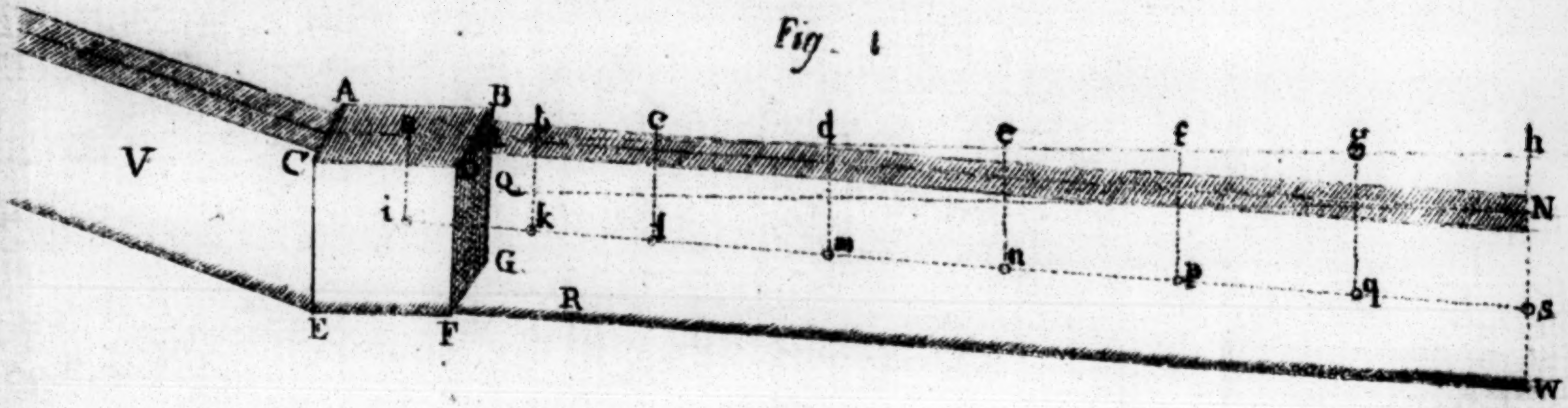


Fig. 1

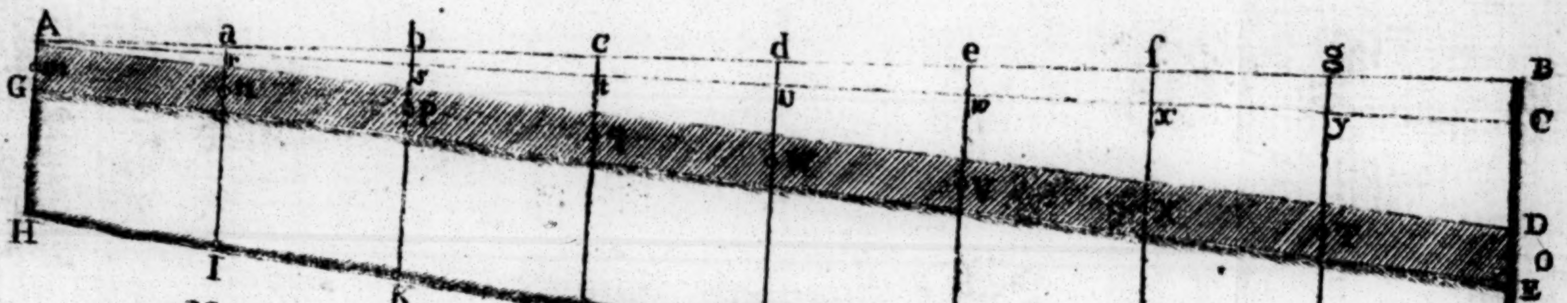


Fig. 2

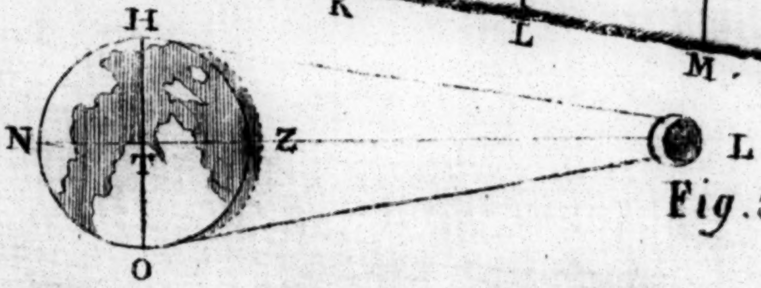
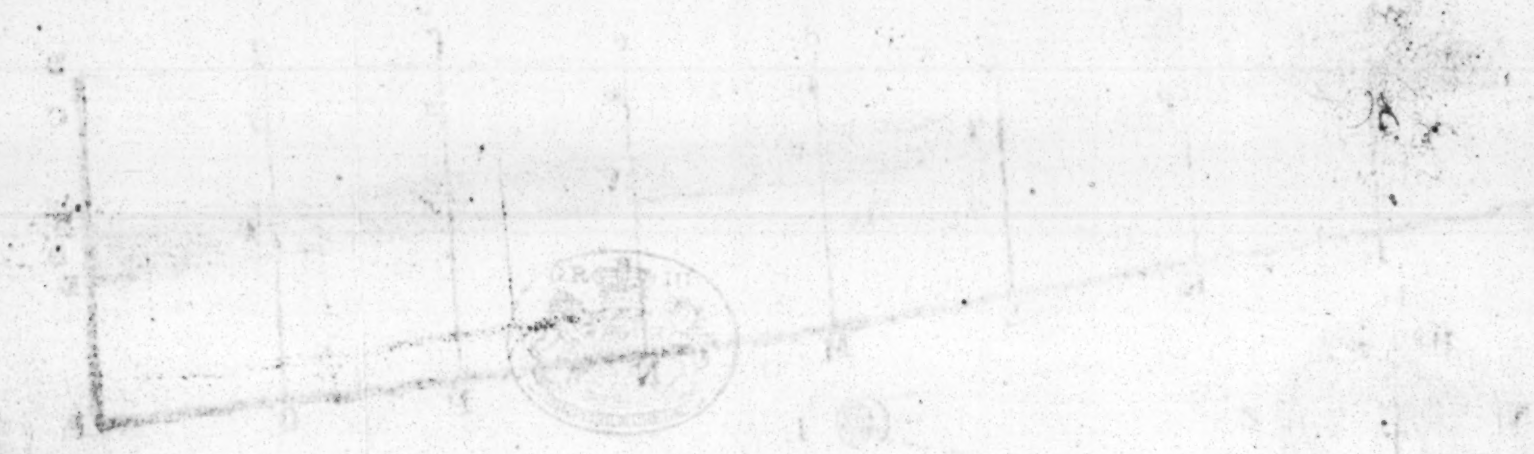


Fig. 3



ing ever near the Meridian where the Moon is Vertical, ſhe making high Water ſoon after the Time of her appulſe to the Meridian wherever ſhe is preſent. As at the Meridian, *HZO* when the Moon is Vertical at *L*, and from a round Figure (which the Ocean would otherwiſe have in a State of Reſt, by the preſſure of Gravity towards its own Center of the Earth) it is forced into a Spheroidick Figure, whoſe longeſt Diameter is where the Moon is Vertical, as *NZ* is longer than *HO*: And the Earth revolving round its own Axis once in every Day, occaſions thereby the two Floods and Ebbs obſervable every 25 Hours, which happen to make the juſt length of a Lunar Day.

As the longeſt Diameter of the Spheroidick or Oval Figure of the Ocean would if a ſtrait Line was produc'd, as N Z to L, paſs thro' the Moon, the the Water near that Meridian is conſequently higheſt, at that inſtant of time: And as the Gravitation of the Sea toward the Moon is equal in the ſame Meridian, therefore the height of High Water of that Tide will in all different places of High Water be equal, and conſequently a true Level in the main Ocean. And as the active impulſe of the Moon when once impreſs'd upon the Water, forces the Tide to riſe rather above the Level of the ordinary height of the Ocean in Bays and large mouth'd Rivers, as in the Bay of St. *Malo* in *France*, in the Lake of *Venice*, in the Bay *Æſtuarium Metaris*, into which the River *Welland* and four other Rivers fall, &c. and does the ſame where it enters into long Chanels, which running far into the Land, grows ſtrait at their Extremity as it is in the River *Severn, Ouſe*, &c. (*as is obſerv'd in the Philoſophical Tranſactions*, vol. 2. p. 264) And alſo by this Impulſe the Tide continues flowing up the Rivers, even while Water is falling back to Seaward, juſt behind High Water; and in Spring Tides the head of a Flood at its coming in from Sea riſeth in height like a Wall, call'd an Egar or Boar, ſometimes 9 Foot high, and ſo runs for many Miles together, up *Severn, Ouſe*, &c. and even after it is High Water the Tide is driven on up the Rivers by the firſt Impetus, and flows a conſiderable time even while it ſhrinks ſometimes above a Foot, at the place where it had been High Water; all which ſhews that the Tides do not flow by *deſcent* in Rivers as Land Waters do and as Mr. *Grundy* aſſerts, but by Impulſe, according to Sir *Iſaac Newton*'s Theory of the Tides; making it's High Water Mark an Horizontal Level, ſo far as it flows, up the Rivers, as well as in the Ocean.

In order to prove that the Tide doth not run with an Inclination or declivity from the Sea, into any River as Mr. *Grundy* ſuppoſes in his ſecond Propoſition, as from B. to A. *Fig.* 2. Let B. be the Port of *Lynn*, and A. the City of *Ely* 30 Miles from *Lyn* up the River. Then, as according to *Hydroſtatick-Principles*, and to his *Firſt Propoſition*, the declivity from B. to A. muſt be greater or leſs in Proportion, to the ſwift or ſlow rate the Water runs, it will follow, that the High-water at *Lynn* muſt be at leaſt 100 Foot higher, than High-water can be at *Ely*; for He ſays, in his Book, that *when the Doors of Capt.* Perry's *Sluice at* Spalding *were drawn up, and* Cowbit-waſh *pretty full* (*above the Sluice*) *the velocity of the Stream was but* 140 *Foot in a Minute.* But the velocity of a Spring-Tide may be above 900 Foot in a Minute, *Example.* When it was High-water at *Lynn* at 22 Minutes after 8 a Clock, it was High-water at *Salters-Lode* (16 Miles up the River from *Lynn*) 55 Minutes after 9 a Clock, ſo that the Tide flow'd 16 Miles in an hour and half, or 900 Foot in a Minute, which was with *ſeven Times* more velocity, than the Scour at *Spalding* ran when the Sluices were opened; conſequently this Tide according to Mr. *Grundy*'s Demonſtration, ought to have had *ſeven Times* the fall or Inclination that, that Scour had, and if ſo, the High-water at *Lynn*, muſt have been 60 Foot higher than the High-water at *Salters-Lode*, and near 100 Foot higher than the High-water at *Ely*, that is

100 Foot higher than the Country about *Lynn*; but the Tide roſe but 16 Foot high, and was not ſo high as their Banks, therefore this Propoſition of Mr. *Grundy*'s is founded upon falſe Principles.

I having obſerv'd the Phænomenon of the Waters flowing ſtill on after High Water at all places, till it ſometimes ſhrunk above a Foot: I have taken a Level by an Inſtrument, (particularly from *Magdalen*, on the River *Ouſe*, to *Salters Lode*, 7 Miles, and found that the Water did move up Hill while it ſhrunk; aud that the High Water mark of the Tide at thoſe places was very near Level. I obſerv'd the ſame between *Lyn* and St. *Germans*, the diſtance by Land 3, by Water 7 Miles, and there I took the Level by a Teleſcope Inſtrument at one middle Station. When Mr. *Grundy* was taking the Levels of the Country about *Spalding*, 1734, for 22 Miles in length, which he ſays he took with an Inſtrument in upwards of 2500 *Stations* to the Sea, in order to drain the Country, and amend the Navigation: He might have made Marks at High Water in the River *Welland* at a few places betwixt the Sea and *Spalding*, and then next have taken the Level of thoſe places by his Inſtrument, (as I have done on the *Ouſe*, and doubtleſs others on other Rivers, where they thought the *Friction* or other *Phænomena* requir'd it) by which means he would have found whether there was any great difference between the *Level* taken by his Inſtrument, and the *Level* taken by the Tide; had he done ſo, I have reaſon to believe, that in the *Welland*, as I have found in the *Ouſe*, *&c.* that if there is found Deſcent to drain the Country by *Levels* taken by the Tide, there would too be found Deſcent enough by the *Levels* taken by an Inſtrument. Tho' indeed the *Level* of a Country taken by an Inſtrument at the great number of Stations mention'd by Mr. *Grundy* will be very uncertain, from the difficulty of adjuſting the Inſtrument and Bubble in an exact Horizontal Poſition, the taking the Ray, and cutting the vane of the Station Staff exactly Horizontally, the Sights thro' which one looks being but a little way aſunder, and alſo from the unequal diſtance of the Stations. * Whereas, as the Tides flow regularly the taking the *Level* by an Inſtrument at 2 or 3 Places too, at their High-water-mark, will by Proportion, ſhew what difference there is for the whole length of the Flood of Tide between a High-water-mark Level, and an Inſtrument Level.

And I never did nor ſhall truſt to an Inſtrument alone, if it muſt be us'd at a great many Stations, where there is a Tide, by which the Level can alſo be taken; for the Theory of the Tide being found to be true, the taking a Level by the Tide cannot be founded upon falſe Principles, as Mr. *Grundy* endeavours to ſhew by a ſpeculative Demonſtration, without bringing any Examples or Experiments to prove it in Fact.

However, I ſhould hardly have taken Notice of this Propoſition of his, if he had not inferr'd from it, that the ſeveral undertakings to drain deeping Fens in South *Holland* in *Lincolnſhire* did not ſucceed, becauſe the Levels were taken upon falſe Principles, reflecting upon Captain *Perry* and others upon that account, in a Sheet of Paper printed 1734, which falſe Aſſertion may miſlaid the Inhabitants of that Country to Expenſive and fruitleſs Undertakings, unleſs they can be Convinc'd, that the want of laſting Succeſs in thoſe Undertakings (for preſent ſucceſs they had) was owing to other Cauſes; and thoſe which I take to be the true Ones, are in theſe Papers offer'd to their Conſideration.

---

* For which Reaſon the Barometer is attempting to be improv'd to take Levels more exactly by the riſe or fall of the Mercury.

D. Benedetto Caſtelli, Mathematician to Pope *Urban* 8. and Profeſſor in *Rome.*

His Account of the cauſe of Ports and Rivers being choaked up, or a preſerv'd Navigable on the Coaſts of the *Mediterenian*, and the Bay of *Venice.*

AS to the great ſtoppage of Ports, I hold that all proceedeth from the violence of the Sea, which eſpecially at the time of the Waters flowing doth raiſe from its bottom immenſe heaps of Sand, carrying them by the Tide and force of the Waves, and if the Ebb, hath not Strength to carry them away, they ſink to the bottom, and ſo they choak up the Ports; and that this Effect happeneth in this Manner, we have moſt frequent experiences thereof along the Sea Coaſts: And I have obſerv'd in *Tuſcany* on the *Roman-ſhores* and in the Kingdom of *Naples* (*where the Tides riſes but very little*) that when a River ſaleth into the Sea, there is always ſeen in the Sea it ſelf, at the place of the Rivers Outlet, the reſemblance at it were of an half Moon, or a great Shelf (*or Bar*) of ſettled Sand under Water, much higher than the reſt of the Shore, the which cometh to be cut by the current of the River, one while on the right Side, another while on the Left, and ſometimes in the Midſt, according as the Wind ſits.

Now whoſo well conſidereth this Effect, plainly ſeeth, that it proceeds from no other, than from the contrariety of the ſtream of the River, to the *impetus* of the Sea Waves; ſeeing, that the great abundance of Sand which the Sea continually throws upon the Shore, cometh to be driven into the Sea by the ſtream of the River, and in that Place where thoſe two Impediments meet with equal Force, the Sand ſetleth under Water, and thereupon is made that ſame Shelf; the which, if the River carry Water, and that any conſiderable Store, it ſhall be thereby cut and broken, one while in one Place, and another while in another; and through that Chanel it is, that Veſſels fall down into the Sea, and again make to the River as into a Port. But if the Water of a River ſhall not be continual or ſhall be weak, in that caſe the force of the Sea ſhall drive ſuch a quantity of Sand into the mouth of the Port, and of the River as ſhall wholly choak it up.

Now it is neceſſary to make the like Reflections on our Ports of *Venice, Malamocco, Bondolo,* and *Chiozza*; which in a certain Senſe are no other than Creeks, mouths and openings of the Shore, that parts the Lake from the main Sea; and therefore I hold, that if the Waters in the Lake were plentiful, they would have ſtrength to ſcour the mouths of the Ports throwly, and with great force; but the Waters of the Lake failing, the Sea will without ſufficient oppoſal bring ſuch a drift of Sand into the Ports, that if it doth not wholly choak them up, it ſhall render them at leaſt Unprofitable, and impoſſible for Barks and great Veſſels to Navigate. *Page* 65.

The Lake of *Venice* ſilting up, after the River *Brent* was deverted, and the Navigation of the Ports being threatened with irreparable Ruin. *D. Caſtelli* was employ'd to propoſe a Remedy. *And it was this, to uſe his own Words*, that there be reſtored to the *Lake* as much Water as can be poſſible, and in particular from the upper parts of *Venice*, and that this is the true and real Remedy, of the preſedent Diſorders is manifeſt: For in the paſſage that this Water ſhall make thro' the *Lake*, it ſhall of it ſelf by

degrees

degrees clear the Chanel, *&c.* And this abundance of Water being always to diſcharge it ſelf into the Sea, by the Ports, I do not doubt, but that their bottom will be Scour'd. And therefore am for the returning of *Brent* again into the *Lake*, *&c.* Laſtly, the Current of theſe Waters, which muſt iſſue out of the *Lake* into the Sea, beſide thoſe of the Tide, the Port will be kept ſcoured and clear, ſo far *D. Caſtelli.*

It is apparent that the Works executing for the amending the Navigation of *Cheſter*, are directly oppoſite to the Remedy this great Man propos'd for amending the Navigation of *Venice*. And the Method here executing, being Parallel to thoſe done at *Oſtend*, which they were forc'd to Demoliſh again to ſave the Port; being Parallel to thoſe done at *Lynn*, *Wisbech*, *Spalding*, *Wells*, *Rye*, *Ipſwich* and *Exeter*, the Navigation of all which Ports have been highly Prejudiced by ſuch Works, and prodigious Sums of Money have ſince been expended, to give ſome of them as good a Navigation by Art in Vain! It is apparent that the Navigation of *Cheſter* will after the compleating of theſe Works be utterly Deſtroy'd, the *Hyle-Lake* where the *Royal Navy* have Rode, and the only Road where they can Ride over againſt *Ireland*, will be choaked up, and the Navigation of *Liverpoole* over the Bar, and *Horſe Chanel* rendered impractable very ſoon, and in time worſe Conſequences will follow. For it appears from the Caſe of *Lynn* at home and *Venice* abroad, that when one River is choaked or deverted, whoſe Outfals was near to another, the other has Decayed, and that for very obious Reaſons.

ADVERTISEMENT.

ALL ſorts of Mathematical Inſtruments, are Made and Sold at Mr. *Wrights*, at the *Orrery* and *Globe*, in *Fleet-ſtreet*, *London.*

PHILOSOPHICAL AND MATHEMATICAL REASONS,

Humbly offer'd to the Conſideration of the

PUBLICK,

To prove that the Preſent Works, executing at *Cheſter*, to recover and preſerve the Navigation of the RIVER DEE, muſt intirely Deſtroy the ſame. With ſome REMARKS on Mr. *Badeſlade*'s REASONS, *&c.* thereon.

CHESTER: Printed for ROGER ADAMS.

IN *May*, 1735, I view'd the Works carrying on at *Cheſter*, under the pretence of making better the Navigation of the River *Dee*, from that antient and honourable City to the Sea. And was very much ſurpriz'd to find them ſo far from being calculated to improve; that they ſeem'd in my humble Opinion plainly to tend to deſtroy the Navigation, and to cut off all Communication to and with the Sea from *Cheſter*, if the Works ſaid to be propos'd were carried into execution.

I told ſome Gentlemen my Opinion of the Works than made, and alſo of what I could learn was deſign'd to be done, which I afterwards deliver'd in Writing to the following Effect, *viz.* that the *new Canal* was cut through much too high a Soil; that it was made very improper as to its Capacity; that the Laws of Motion and Percuſſion will evidently prove its Courſe or Direction to be very irregular and diſadvantageous, as well with Reſpect to its receiving and conveying the Land-Floods as the Tides: And that it wou'd be very difficult, if not impoſſible to gain any Way or Paſſage to the Sea, which wou'd not be filted and choak'd up at the Mouth of it againſt all the Force that could be gained from the back Waters. In ſhort, the whole Undertaking ſeems to be carried on, not only againſt Sir *Iſaac Newton*'s Theory of the Tides, but againſt all the common and receiv'd Rules in Practice, and daily Uſe in Mechanicks and Mathematicks, as well as againſt, and directly contrary to other Rules plainly and juſtly deducible in Theory therefrom, and confirm'd by Experiments; and quite againſt and contrary to Nature.

I humbly conceive, that every Lover of, and impartial Inquirer after Truth, will allow that the very Foundation of making Rivers Navigable, of reſtoring a loſt, or improving a bad or indifferent Navigation, and of draining Lands, depends upon the Knowledge of natural Philoſophy and Mathematicks, in all its Branches, and that the Undertaker of ſuch ſort of Works ought to be a good practical Surveyor, and able to take his own Levels, and to draw his own Maps: Without theſe Qualifications, (and the more they are improv'd by Obſervation and Experience, the better) I apprehend it exceeding difficult, if not impoſſible for an Undertaker in Affairs of theſe Natures, to ſucceed in ſuch complicated Works, whoſe Uſefulneſs or Defectiveneſs will be in proportion to the Degree of his Improvement and Skill.

THE Duty and Reſpect I owe to every Man, requires, that I pay that Regard to Mr. *Badeſlade*, which his Merit deſerves. I have not the Honour to be known to that Gentleman, but in juſtice to him, I think myſelf obliged to acknowledge, that the Publick is much indebted to him for the judicious Remarks he has publiſh'd on the Subject

of

E.

of Navigation and Draining, which I freely confeſs are in my little Apprehenſion the beſt yet extant. But with the greateſt Deference to his Judgment, I muſt beg leave to ſhew, that I believe he is miſinfrom'd in ſome Circumſtances relating to *Deeping*-Fenn, and the River *Welland*; and that there is a Poſſibility, the Inſtances, which that ingenious Gentleman brings as Parallel to *Cheſter*, may not in reality be altogether ſuch. For I cannot but be of Opinion, that no Man can tell, whether this, that, or the other Place is parallel to another, or ſay how far they are parallel, unleſs he draws the Maps and takes the Levels of the Places propos'd to be compar'd. It muſt be own'd, that particular Circumſtances may make a wide Difference; and that theſe Circumſtances and Differences cannot I humbly conceive be found out, or known by any other Art or Method than that of Mapping and Levelling, from whence alone Facts can be ſtated, Contents and Capacities judged of, and proper Works projected for Execution, according to the Facts, Falls, and Circumſtances of the particular Place.

CAN Length, Width, Depth, Height and Capacities be known or judged of with any Degree of Certainty without Menſuration and Calculations therefrom? Surely no: I therefore lay it down for a Rule, that no body can make the trueſt Judgment (human Affairs are capable of) in any Caſe of Navigation or Draining, or ſo good and certain a one without taking of Levels and Drawing of Maps, as with it; nor can any Artiſt tell wherein any complicated Work is Defective, or ſhew the Occaſion of the Defects unleſs he has his Information from juſt Maps and Levels. This therefore in my humble Opinion is ſo abſolutely neceſſary to be firſt done, that a Superſtructure cannot be juſtly or with certainty rais'd without it.

IN the Years 1731. 2, 3 and 4, I was employ'd in and near *Spalding* in *Lincolnſhire*, not only to ſurvey Land, but to draw Maps, and take the Levels, in order, as well to drain, as to make better or improve the Navigation (which was very bad and almoſt loſt) of the River *Welland*. By the orders of the Adventurers in *Deeping*-Fenn I drew Map of that River in 1734, of about twenty two Miles in Length, and took the Levels thereof in upwards of two thouſand five hundred different Places or Stations, to a little below *Foſdyke*-Waſh-Houſe and from thence I went in Boats down to the Scalp.

Mr. *Badeſlade* in his Reaſons, &c. lately printed at p. 5. ſays, "Water requires at
" leaſt ſix Inches in one Mile's Deſcent to flow or move at all. And in page 9 he
" ſays, that about the Year 1730, Capt. *Perry* undertook to *drain that Country*, by *Sluices*
" ſet down croſs the *River* above *Spalding*, to hold up between the *Banks* of the *River*
" the *freſh Waters* to a conſiderable Height, and to take in and hold up high *Spring*
" *Tides*, (for ordinary *Tides* cou'd not reach him) and to let the *Scour* off, when the
" *Tide* was *ebb'd* out of the *River*. The *Proprietors had great Expectations*, but when the
" *Scour* was let off, it only pool'd a Depth near the *Sluice*, and threw up a Barr of Sand a
" little beyond; and though the Captain us'd *Porcupines* and other Devices to move the
" *Sand*, yet it ſubſided again at a ſmall Diſtance, and cou'd not be driven out to *Sea* by
" the Force of his *Scour*, though the *River* is narrow, and but ſeven Miles long from
" the *Sluice* to the *Sea*.

I have drawn up at the End of theſe Remarks two Propoſitions, one to prove that Water will move along a River or Canal that hath but four Inches Fall in each Mile, and the other to prove no Level can be taken betwixt two diſtant Places in any Channel by the different Height of the ſame Tide at thoſe two Places; to which I beg leave to refer my Reader.

IN the Year 1734, and in *April* 1735, I found the following Facts upon the River *Welland*, and the Channel a little below the Waſh-Houſe aforeſaid. From Capt. *Perry's* Sluice thither, is upwards of nine Miles and a half, and the Floor of that Sluice was higher by twenty-two Inches than the Bottom of the Channel there, from an Horizontal Plain. Where the Inclination of the Bottom of the River three Miles below, that Sluice was but two Inches and a half, I there found, when the Doors of the Sluice were drawn up, and *Cowbit-Waſh* pretty full, (above the Sluice) the Velocity of the Stream to be 140 Feet in one Minute. I found no Barr of Sand nearer than upwards of three Miles below this Sluice, nor any Depth of Water pool'd near the ſaid Sluice, or deeper than the Floor or Bottom of it, except where it was dug out with Spades by Captain *Perry*'s Orders. An ordinary Tide Mr. *Badeſlade* admits does not reach

the

the Sluice; yet the Navigation was worſe before it was let down, than it has been ſince. The Sluice therefore ſeems for the above Reaſons to have been in ſome Degree uſeful and of Advantage.

IF as Mr. *Badeſlade* has remark'd there is ſixty Foot Fall from *Cheſter* to the Sea, and if there is not two Foot Fall from Capt. *Perry*'s Sluice to the Channel aforeſaid, than by conſidering the Nature of Bodies rolling along different inclin'd Plains; we may conclude, that in this Circumſtance, the parallel Caſe between *Cheſter* and *Spalding* is as 60 to 2, then there is the ſame Difference between the ſame Scheme, if ſuppos'd to be evecuted at both Places.

THE ſame Reaſoning I apprehend will hold good in any other Place, making Allowance for the Length and Inclination of their different Plains to Sea, and the different Inclinations of the Lands on each ſide the Bay.

Mr. *Badeſlade* ſays in page 6. That after *Saltney-Marſh* is embank'd, and the *white Sands* are gain'd from the *Sea* not only the *Navigation* will be loſt, but alſo the *Low-Lands* above *Cheſter*, adjacent to the River *Dee*—And again in page 8.—Therefore when the Salt-Marſhes and *white Sands* belonging to *Cheſter River* are embank'd, of neceſſity *Hyle-Lake* and the *Barr* muſt grow up and the *Navigation* be deſtroy'd for want of a ſufficient *Flow* or *Reflow* of the *Tide-Water* to keep 'em open, in like Manner, as did the *Outfall of Rye*.

I don't rightly apprehend this Gentleman's meaning, there's a Poſſibility, as I have ſaid above, that the Inſtances we apprehend to be Parallel, may not be ſo in Fact, and that *Circumſtances* may make a wide Difference. At preſent I am of Opinion (which I can't rectify without Surveying and Levelling the whole) that all the Lands and Sands above *Wepprаw-Gutter* may be made good Lands without any Prejudice to the Navigation, or to the draining the adjacent Lands. And that the imbanking *Salt-Marſhes* in *ſome Degree*, is ſo far from being prejudicial, that it is of the higheſt Advantage to both, and quite agreeable to all receiv'd Principles in *Hydroſtaticks* and *Mechanicks*, as well as to the conſtant Laws of Motion: for where the Inclination of the Plain is the ſame, it will ſurely be allow'd, that a large and deep Channel, whoſe Capacity is found by Calculation to be juſtly proportion'd, and fit to receive all ſuch Waters as muſt Flow and Reflow thro' it, has a greater Momentum to remove any Obſtruction, than the large diſproportion'd and widely extended ſhallow Channel.

I appeal to the moſt Judicious of thoſe, who have been, or are the beſt acquainted with the *Cheſter* Channel, whether if ſuch a Channel might (by any Art) be gain'd as wou'd be found ſufficient to receive all the Waters that muſt Flow and Reflow thro' it in a common Spring-Tide, where there is the greateſt Fall, as far as *Burton*-Head; and if the Cauſeway at *Cheſter*-Bridge was taken away, in order to give the Tides the greater Liberty to flow up the River, their Navigation might not be improv'd thereby to the greateſt Perfection it is now capable of.

THEN conſequently if ſo, the remaining Sands as far as *Burton*-Head above the Capacity of ſuch a Channel, might be bank'd in, and made good Land, without any Prejudice to the Navigation.

I entirely agree with Mr. *Badeſlade*, "That no Man's ſingle Judgment "ought to be taken, and no Scheme of this publick Nature ought to be "executed without the general Approbation of the beſt Judges." And I crave

" ceave leave to add, a proper Scheme ſhall be produced, whenever the Publick ſhall require it of their.

Moſt Humble and moſt Obedient Servant,

JOHN GRUNDY

PROPOSITION I. (Fig. I.)

Suppoſe ABCDEFG, to be a Reſervoir of Water, and that from the ſaid Reſervoir there be made the Canal MNRW, whoſe Inclination with regard to the Horizontal Line *ab* is four Inches Fall in each Mile, and that the Length of the ſaid Canal to its Outfall at NW, is ſix Miles. Let us ſuppoſe BDFG to be a Sluice, and another to be plac'd at NW; now, if we ſuppoſe the ſaid Reſervoir full of Water up to the Surface QN; *Quære*, If the Sluice BDFG, and that at NW be both drawn up above their reſpective Surfaces of Water, will the ſaid Water have any Motion at all along the ſaid Canal?

THIS Propoſition needs no Demonſtration, becauſe from Experience it is now become a receiv'd Truth amongſt moſt modern Engineers, that Water will run along any River, whoſe Inclination is not above four Inches, or four Inches and a half Fall in one Mile but to prove from ſelf-evident Truths it muſt be ſo, it may not be amiſs to give the following Demonſtration.

WHILST the Water in the ſaid Reſervoir and Canal are in a ſtate of Reſt, it is ſelf-evident from the Laws of Gravity, that their Surfaces muſt be plain and parallel to the Horizon, or rather a Segment of a Sphere concentrical with the Earth. For as the Particles of Water are ſuppos'd to yield to any Force impreſs'd, they will be mov'd by the Action of Gravity, till ſuch time as none of them can deſcend any lower. When this Situation is once attain'd, the Fluid muſt remain at reſt, (unleſs put in Motion by ſome foreign Cauſe,) becauſe none of the Particles can now move without aſcending, contrary to their natural Tendency.

Secondly, Whilſt the Particle *i* is reſt, it is manifeſt from the Laws of Hydroſtaticks, it muſt be preſs'd upon equally on all Sides by ſuch other Particles which ſurround it: for if it was not ſo, it muſt yield to the ſtronger Force ſo long, till it it is equally preſs'd every where; and when it is equally preſs'd on all Sides, (as it muſt be when at reſt) it is plain, from the third Law of Nature, that it muſt have a Re-action ſo great, as to equally preſs whatever is contiguous to it, in all manner of contrary Directions. Then conſequently the Force by which any Particle of Water, that is at reſt, preſſeth againſt any like Particle that is contiguous to it, muſt be equal to the Weight of the incumbent Column of Water above it: therefore the Preſſure it muſt ſuſtain in itſelf from any other part, or according to any other Direction, muſt likewiſe be equal to the Weight of the ſame incumbent Column; and ſince Action and Re-action are equal, we may from thence conclude, that the Particle *i* muſt preſs in all manner of Directions with the ſame Force that is equivalent to the Weights of its incumbent Column *i a*.

NOW if the Sluice at NW, and BDFG be both drawn up, it is plain by Conſtruction, as well as the aforeſaid Laws of Gravity, that the particle

i will deſcend to k; and there its Preſſure to move forwards will be in proportion greater than when at i, as $b\,k$ is greater than $a\,i$. By the ſame way of reaſoning the Particle at S, will deſcend into its Outfall, and make way for the Particles q, p, n, m, l, to follow it; and then the conſequence muſt be, that the whole Column of Water in the Canal muſt be put in motion, and continue to move, (if there be but the leaſt Deſcent imaginable) ſo long as there is Water to ſupply it from the ſaid Reſervoir at the Head. Which may be further prov'd from mechanical Principles. Thus; the Particle at k being in motion, will be continually accelerating, and will be ſo much greater at l, as a Body in falling from c to l would be accelerated more than than it would be in falling from b to k; by the ſame Laws it muſt move to m, n, p, q, S, and ſo into its Outfall. It is farther evident from Hydroſtatical Principles, that the Velocity of the Water in the ſaid Canal, will be greater or ſmaller; and that in proportion to the different Heights of the Water in the ſaid Reſervoir and Canal. Again, if we ſuppoſe the River or Drain V, to ſupply the ſaid Reſervoir with Water from ſome greater Inclination, than, that of the ſaid Canal, which is generally the Caſe, where Waters are convey'd by Rivers or Drains thro' flat and fenny Countries to their Outfalls. The Water in the Canal M N R W will have its Velocity (in proportion to the Inclination of the River V) increas'd, tho' the ſaid Canal hath no greater Inclination than four Inches in each Mile.

PROPOSITION II.

TO prove that the Difference betwixt the riſing of the ſame Tide at any two different parts as H and F, in any open Bay, or Channel, cannot give the juſt Inclination of the Plain betwixt thoſe two Places.

PREPARATION. (See *Fig.* II.)

LET ADHF repreſent a Section of any Channel where the Tides put in, (as ſuppoſe the Channel between *Cheſter* and *Wild Road.*) Let ADGE repreſent the Surface, and m, n, p, q, W, V, X, T, O, the Low-Water Marks; let m repreſent *Cheſter-Bridge*, and o *Wild-Road*; AC is the Horizontal Line, drawn from the Surface of High-Water at *Cheſter-Bridge*, HF repreſents the Bottom of the Channel, and AB the juſt Inclination up the Channel, the Tide muſt have, before it can move to A.

DEMONSTRATION.

BY the firſt Propoſition it is prov'd, that the Surfaces of Waters are not in an Horizontal Plain, except ſuch Waters are entirely at reſt, without any Motion at all. Then conſequently any River or Channel in motion cannot have its Surface in an Horizontal Plain, but muſt vary from that, in proportion as its Velocity is ſwifter or ſlower, or as its perpendicular Preſſure is increas'd or diminiſh'd.

WE may further learn from the Nature of the Tides, that at their putting into any Channel, the Water is rais'd above its ordinary Level, by being made conſiderably lighter in its ſpecific Gravity, by the joint Attraction of the Moon and Sun (in Spring-Tides;) therefore the Conſequence muſt be, that the Water will be rais'd to B, before it can move forwards, up the River to A: For it is plain from the Laws of Motion, (in fluid as well as ſolid Bodies) that the Water at the putting in of the Tides, muſt riſe ſo high, as to make its Inclination up the Channel in the Direction of BA, before it can overcome the Re-action of the Water in the Channel in its natural Courſe, to cauſe it to move up along with it towards its Head.

FROM what hath been ſaid it appears very plain, that the Water muſt riſe above the Horizontal AC to B, before it can make its Perambulation up the Channel to A; ſo that its whole Riſe during ſuch a Tide, muſt be from O to B, from T to g, from X to f, from V to e, &c. and not from O to C, from T to y, from X to x, from V to w, &c. as by ſome hath been imagin'd.

THEREFORE all thoſe that take it for granted, that the Difference of the Riſe of the ſame Tide at any two ſeparate Places of a Channel, gives the juſt Inclination of the Plain between theſe two obſerv'd Points, muſt vary ſo much from the juſt Inclination of the ſaid Plain as the Line OB is greater than OC; then conſequently, if the taking of the Levels are grounded upou falſe Principles, the reſt of the Proceedings muſt be ſo too, and cannot ſucceed in practice but by meer Accident.

F I N I S.

Mr. John Reynolds, * *his Remarks on the Dam and Sluice making croſs the River* Dee, *to turn the Waters into the New-Cut.*

THERE are two Rows of Piles a croſs the River, each Row of 480 Foot in length or thereabout, and the Rows 20 Foot diſtant from each other, with Whale-Pieces and Land-Ties about 8 Foot diſtant from each other; with a Sluice at the Eaſt-End of the Piles of 60 Foot long, upon the Bottom in Width 34 Foot, with nine Runs of 6 Foot each.

Remarks on the Sluice and Dam as follow.

Some Piles and Stone-Work, have been made for many Years; and two Parts out of three of the Sluice ſtand upon Piles newly driven, which were hollow, in Depth about 8 Foot, and have been filled with Clay; * which in my Opinion cannot be ſafe, by reaſon Piles and Stones cannot lie ſo cloſe as to ſtop Water, for it is nothing but Sand that lies betwixt them; and that Part of the Sluice that is fill'd in with Clay 8 Foot in Depth, and all under Water will ſettle in a cloſer Body, and leave the bottom of the Sluice hollow, * ſo that the Water will have a free Paſſage under, and blow up the Sluice; it is my Opinion, that no Sluice lies ſafe without Dove-Tail Piles driven under the Bottom; be the Earth at the Bottom never ſo good. As to the Piles driven a croſs the River of 20 Foot Diſtance, tis not above one fourth Part of the Width, the Foundation ſhould be; neither can it be tight without a Row of Dove-Tail Piles, by reaſon the Bottom is nothing but Sand and Gravel, and will be liable to blow away the Works every Spring-Tide, * when they come to pen up the Water 5 or 6 Foot in Height: The Piles now driven may ſerve for the South-ſide of the Dam, but if the Stones be thrown in above 10 Foot diſtance from the inner Row of Piles towards the North, it will be a very great Detriment in carrying on the Work in that Place, by reaſon Dove-Tail Piles cannot be driven. As for the Sluice now laid, it is not in a proper Place, by reaſon there cannot be Dove-Tail Piles driven under the Bottom to ſecure it; nor is the Sluice laid low enough to carry the Water ſo faſt as is neceſſary for compleating the Work. *

As for the New Cut, in my Opinion it will do very well with Grinds, made in turns in the Canal, where the Currents ſet: And that the Land will ſwerve and riſe to make good Ground.

---

* A noted Sluice and Dam Maker, imploy'd by the late Capt. *Perry* was ſent in *June* laſt, by the Committee in *London* to *Cheſter*, to give them his Opinion of the Sluice and Dam then making. part of it having been demoliſhed by the Tides.

What Mr. *Reynolds* ſays is ſo true, that in the attempts to ſtop *Dagenham* Breach, in a Bank of the River *Thames*, Mr. *Boſwell* and the Land-Owners, by uſing Materials that guided to Leak-age as detach'd Piles and looſe Stones; after they had expended many Thouſand pounds fail'd, and gave over, tho the Breach was but ſmall at firſt. *Hence this Dam in this way cannot be made.*

When Capt. *Perry* was imploy'd by Act of Parliament to make a Dam croſs that Breach, tho' he went the right Way to Work; and ſecured a Foundation with two Rows of Dove-Tail Piles, 70 Foot wide for the ſeat of his Dam, and uſed Clay only, to make his Dam above the Piles. yet his Work was twice demoliſhed by the Tides (tho' on the Side of the River, and not croſs its Stream) and the Dam was not perfected at laſt for leſs than 22,000 pounds. *The Dam here is 2 3ds longer.*

* The Clay in the Tide-way hath ſince been all waſhed away.

* They have ſince been forc'd to unfloor part of the Sluice, and ram more Clay in.

* The Tides and Freſhes hath ſince waſhed away the Sandy Foundation of the Piles, and great Quantities of Stones have been thrown on the outſide of the Piles to keep them from being carried away.

* This now appears, for tho' not above one third of the Water is as yet forc'd thro' the Sluice, it runs 18 Inches deep thro' it, and if it can be all turn'd thro' the Sluice, will riſe ſo high as to retard the working the Corn and Water Mills.

.

g
s

o
n
n
e

e
,
s
-
n,
l-
y
pe
o
;
o-
g-
i-
ve
ry
n-
re
id

ns
ke

—
ft,
en

of
ge
nd
.
he
70
his
m)
er.

eat
ar-

ce,
n as

Fig. 1

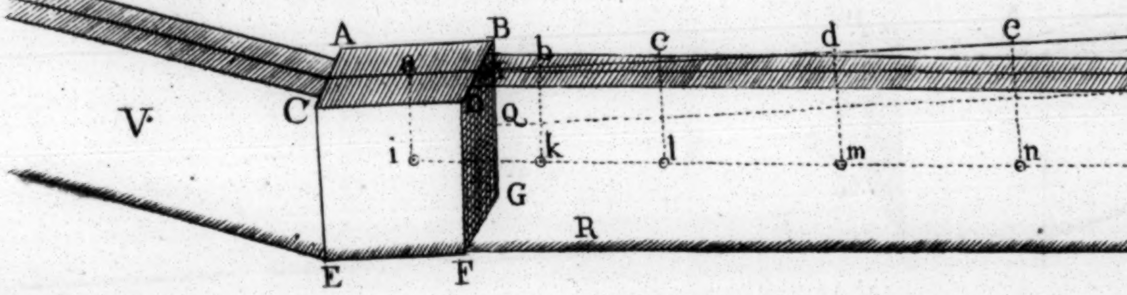
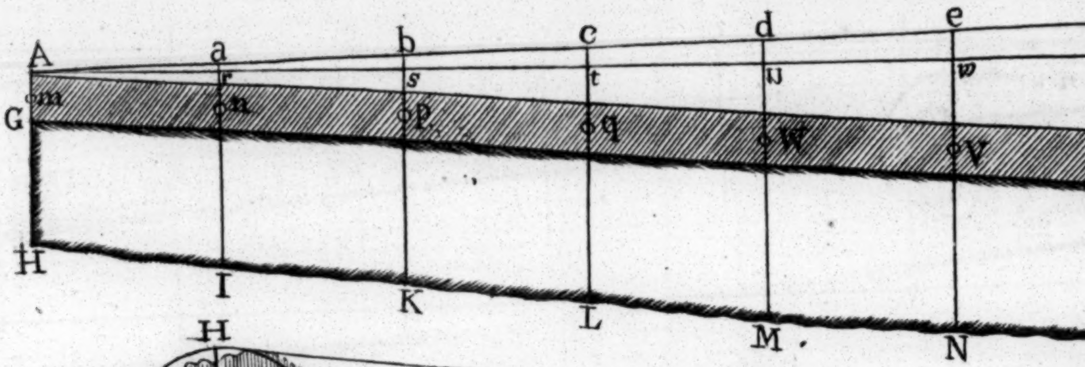


Fig. 2



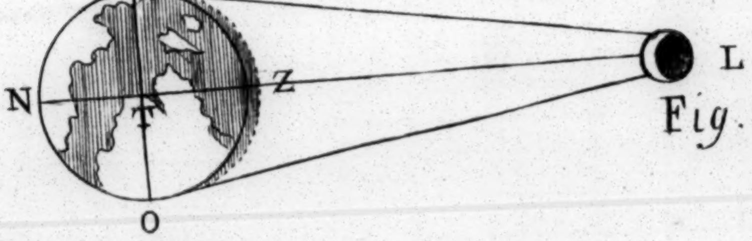
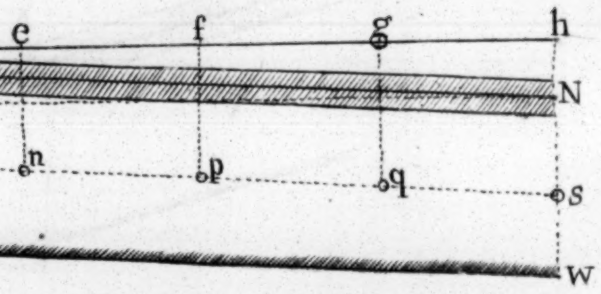
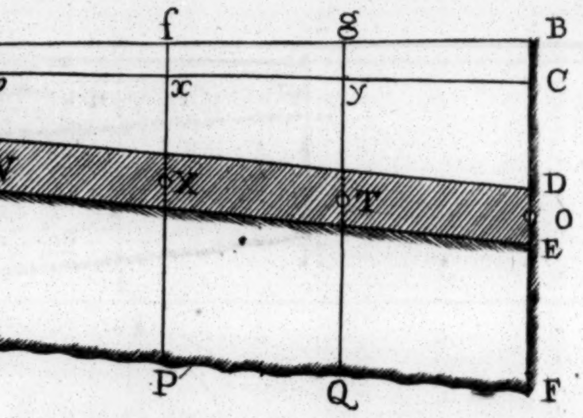


Fig. 3

to retard the working the Corn and Water Mills.


e
f
g
h
N
n
p
q
s
W


f
g
B
C
x
y
D
X
T
O
E
P
Q
F